

**Claims:**

1. A nozzle for an injection molding apparatus, said injection molding apparatus including a mold block, said mold block defining at least one mold cavity having a gate, said nozzle comprising:
  - 5 a nozzle body, said nozzle body defining a nozzle body melt channel that is adapted to be in fluid communication with and downstream from a melt source and that is adapted to be in fluid communication with and upstream from said gate;
  - a valve pin, said valve pin including an upstream portion, said  
10 upstream portion defining a valve pin melt channel, wherein said valve pin melt channel has an inlet and at least one outlet, wherein said inlet and said at least one outlet are in fluid communication with said nozzle body melt channel, said valve pin further includes a tip piece connected to said upstream portion, and wherein said valve pin is movable in said nozzle body  
15 melt channel to control melt flow through said gate;
  - an actuator operatively connected to said valve pin to move said valve pin;
  - a first heating element that is thermally connected to said upstream portion of said valve pin; and
  - 20 a second heating element that is thermally connected to said nozzle body.
2. A nozzle as claimed in claim 1, wherein said valve pin is movable between an open position wherein said tip piece is spaced from said gate to  
25 permit melt flow through said gate, and a closed position wherein said tip piece cooperates with said gate to prevent melt flow through said gate.
3. A nozzle as claimed in claim 2, wherein said second heating element is positioned downstream from said upstream portion of said valve pin.  
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4. A nozzle as claimed in claim 2, wherein a portion of said nozzle body melt channel is heated by both said first and second heating elements.

5. A nozzle as claimed in claim 2, wherein said first heating element surrounds said valve pin melt channel.

5 6. A nozzle as claimed in claim 2, wherein said second heating element surrounds said nozzle body melt channel.

7. A nozzle as claimed in claim 2, wherein said first heating element surrounds said valve pin melt channel, and wherein said second heating  
10 element surrounds said nozzle body melt channel.

8. A nozzle as claimed in claim 2, further comprising a third heating element connected to said nozzle body.

15 9. A nozzle as claimed in claim 8, wherein said first, second and third heating elements are adapted to heat substantially the entire length of said nozzle.

10. A nozzle as claimed in claim 8, wherein said third heating element is  
20 positioned at least partially upstream from said upstream portion of said valve pin when said valve pin is in said closed position.

11. A nozzle as claimed in claim 2, wherein said first heating element is embedded within said upstream portion of said valve pin.

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12. A nozzle as claimed in claim 2, wherein said actuator includes a piston and a chamber, wherein said piston is movable within said chamber, and said piston is operatively connected to said valve pin so that movement of said piston within said chamber causes movement of said valve pin between said  
30 open and closed positions.

13. A nozzle as claimed in claim 2, wherein said chamber is fluidly connected to a source of fluid at a selected pressure on both sides of said piston, so that fluid pressure on each side of said piston can be controlled to control movement of said piston.

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14. A nozzle as claimed in claim 2, wherein said tip piece is removably attached to said upstream portion of said valve pin.

10 15. A nozzle as claimed in claim 2, wherein said valve pin further includes a retainer, wherein said retainer removably attaches said tip piece to said upstream portion of said valve pin, and said retainer has a threaded portion for mating with a corresponding threaded portion on said upstream portion of said valve pin.

15 16. A nozzle for an injection molding apparatus, said injection molding apparatus including a mold block, said mold block defining at least one mold cavity having a gate, said nozzle comprising:

20 a nozzle body, said nozzle body defining a nozzle body melt channel that is adapted to be in fluid communication with and downstream from a melt source and that is adapted to be in fluid communication with and upstream from said gate;

25 a valve pin, said valve pin including an upstream portion, said upstream portion defining a valve pin melt channel, wherein said valve pin melt channel has an inlet and at least one outlet, wherein said inlet and said at least one outlet are in fluid communication with said nozzle body melt channel, said valve pin further includes a tip piece connected to said upstream portion, and wherein said valve pin is movable in said nozzle body melt channel to control melt flow through said gate;

30 an actuator operatively connected to said valve pin to move said valve pin; and

a heating element that is embedded within said upstream portion of said valve pin.

17. A nozzle as claimed in claim 16, wherein said valve pin is movable between an open position wherein said tip piece is spaced from said gate to permit melt flow through said gate, and a closed position wherein said tip piece cooperates with said gate to prevent melt flow through said gate.

18. A nozzle as claimed in claim 17, wherein said heating element surrounds said valve pin melt channel.

19. A nozzle as claimed in claim 17, wherein said heating element includes an electrically conductive film.

20. A nozzle as claimed in claim 19, wherein said heating element is at least partially covered by a protective sleeve.

21. A nozzle as claimed in claim 17, wherein said heating element includes an electrically conductive wire element.

22. A nozzle as claimed in claim 21, wherein said valve pin has an outer surface, and said wire element is embedded in said outer surface.

23. An injection molding apparatus, comprising:  
a mold block defining at least one mold cavity having a gate;  
at least one nozzle, each said nozzle including a nozzle body, a valve pin, an actuator, a first heating element and a second heating element,  
wherein said nozzle body defines a nozzle body melt channel that is adapted to be in fluid communication with and downstream from a melt source and that is in fluid communication with and upstream from said gate,  
wherein said valve pin includes an upstream portion, said upstream portion defines a valve pin melt channel, said valve pin melt channel has an inlet and at least one outlet, wherein said inlet and said at least one outlet are in fluid communication with said nozzle body melt channel, said valve pin

further includes a tip piece connected to said upstream portion, and wherein said valve pin is movable in said nozzle body melt channel to control melt flow through said gate,

wherein said actuator is operatively connected to said valve pin to  
5 move said valve pin,

wherein said first heating element is thermally connected to said upstream portion of said valve pin,

and wherein said second heating element is thermally connected to said nozzle body.

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24. An injection molding apparatus as claimed in claim 23, wherein said valve pin is movable between an open position wherein said tip piece is spaced from said gate to permit melt flow through said gate, and a closed position wherein said tip piece cooperates with said gate to prevent melt flow  
15 through said gate.

25. An injection molding apparatus as claimed in claim 24, wherein said second heating element is positioned downstream from said upstream portion of said valve pin.

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26. An injection molding apparatus as claimed in claim 24, wherein a portion of said nozzle body melt channel is heated by both said first and second heating elements.

25 27. An injection molding apparatus as claimed in claim 24, wherein said first heating element surrounds said valve pin melt channel.

28. An injection molding apparatus as claimed in claim 24, wherein said second heating element surrounds said nozzle body melt channel.

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29. An injection molding apparatus as claimed in claim 24, wherein said first heating element surrounds said valve pin melt channel, and wherein said second heating element surrounds said nozzle body melt channel.

5 30. An injection molding apparatus as claimed in claim 24, further comprising a third heating element connected to said nozzle body.

31. An injection molding apparatus as claimed in claim 30, wherein said first, second and third heating elements are adapted to heat substantially the  
10 entire length of said nozzle.

32. An injection molding apparatus as claimed in claim 30, wherein said third heating element is positioned at least partially upstream from said upstream portion of said valve pin when said valve pin is in said closed  
15 position.

33. An injection molding apparatus as claimed in claim 24, wherein said first heating element is embedded within said upstream portion of said valve pin.  
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34. An injection molding apparatus as claimed in claim 24, wherein said actuator includes a piston that is movable within a chamber, wherein said piston is operatively connected to said valve pin so that movement of said piston within said chamber causes movement of said valve pin between said  
25 open and closed positions.

35. An injection molding apparatus as claimed in claim 24, wherein said chamber is fluidly connected to a source of fluid at a selected pressure on either side of said piston, so that fluid pressure on either side of said piston  
30 can be controlled to control movement of said piston.

36. An injection molding apparatus as claimed in claim 24, wherein said tip piece is removably attached to said upstream portion of said valve pin.

37. An injection molding apparatus as claimed in claim 24, wherein said  
5 valve pin further includes a retainer, said retainer removably attaches said tip piece to said upstream portion of said valve pin, and said retainer has a threaded portion for mating with a corresponding threaded portion on said upstream portion of said valve pin.

10 38. An injection molding apparatus, comprising:  
a mold block defining at least one mold cavity having a gate;  
at least one nozzle, each said nozzle including a nozzle body, a valve pin, an actuator, and a heating element,  
wherein said nozzle body defines a nozzle body melt channel that is  
15 adapted to be in fluid communication with and downstream from a melt source and that is in fluid communication with and upstream from said gate into one of said mold cavities,  
wherein said valve pin includes an upstream portion, said upstream portion defines an valve pin melt channel, wherein said valve pin melt channel  
20 has an inlet and at least one outlet, wherein said inlet and said at least one outlet are in fluid communication with said nozzle body melt channel, said valve pin further includes a tip piece connected to said upstream portion, and wherein said valve pin is movable in said nozzle body melt channel for controlling melt flow through said gate,  
25 wherein said actuator is operatively connected to said valve pin to move said valve pin,  
and wherein said heating element is embedded within said upstream portion of said valve pin.

30 39. An injection molding apparatus as claimed in claim 38, wherein said valve pin is movable between an open position wherein said tip piece is spaced from said gate to permit melt flow through said gate, and a closed

position wherein said tip piece cooperates with said gate to prevent melt flow through said gate.

40. An injection molding apparatus as claimed in claim 39, wherein said  
5 heating element surrounds said valve pin melt channel.

41. An injection molding apparatus as claimed in claim 39, wherein said heating element includes an electrically conductive film.

10 42. An injection molding apparatus as claimed in claim 41, wherein said heating element is at least partially covered by a protective sleeve.

43. An injection molding apparatus as claimed in claim 39, wherein said heating element includes an electrically conductive wire element.  
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44. An injection molding apparatus as claimed in claim 41, wherein said valve pin has an outer surface, and said wire element is embedded in said outer surface.

20 45. A nozzle for an injection molding apparatus, said injection molding apparatus including a mold block, said mold block defining at least one mold cavity having a gate, said nozzle comprising:

a nozzle body, said nozzle body defining a nozzle body melt channel that is adapted to be in fluid communication with and downstream from a melt  
25 source and that is adapted to be in fluid communication with and upstream from said gate;

a valve pin, wherein said valve pin is movable in said nozzle body melt channel to control melt flow through said gate; and

a heating element that is embedded within said valve pin.  
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46. A nozzle as claimed in claim 45, wherein said valve pin is movable between an open position wherein said tip piece is spaced from said gate to



permit melt flow through said gate, and a closed position wherein said tip piece cooperates with said gate to prevent melt flow through said gate.

47. A nozzle as claimed in claim 46, wherein said heating element is at least partially covered by a protective sleeve.

48. A nozzle as claimed in claim 46, wherein said heating element includes an electrically conductive wire element.

49. A nozzle as claimed in claim 46, wherein said valve pin has an outer surface, and said wire element is embedded in said outer surface.

50. An injection molding apparatus, comprising:  
a mold block defining at least one mold cavity having a gate;  
at least one nozzle, each said nozzle including a nozzle body, a valve pin and a heating element,  
wherein said nozzle body defines a nozzle body melt channel that is adapted to be in fluid communication with and downstream from a melt source and that is in fluid communication with and upstream from said gate into one of said mold cavities,  
wherein said valve pin is movable in said nozzle body melt channel for controlling melt flow through said gate,  
and wherein said heating element is embedded within said valve pin.

51. An injection molding apparatus as claimed in claim 50, wherein said valve pin is movable between an open position wherein said tip piece is spaced from said gate to permit melt flow through said gate, and a closed position wherein said tip piece cooperates with said gate to prevent melt flow through said gate.

52. An injection molding apparatus as claimed in claim 51, wherein said heating element is at least partially covered by a protective sleeve.

53. An injection molding apparatus as claimed in claim 51, wherein said heating element includes an electrically conductive wire element.

- 5 54. An injection molding apparatus as claimed in claim 51, wherein said valve pin has an outer surface, and said wire element is embedded in said outer surface.